Claims

1. Electroluminescent device comprising in this order

(a) an anode

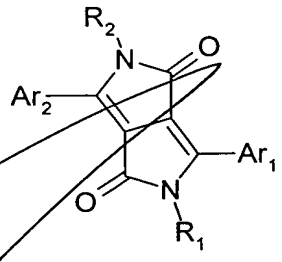
(b) a hole transporting layer

(c) a light-emitting layer

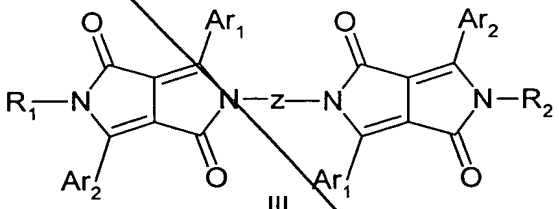
(d) optionally an electron transporting layer and

(e) a cathode

and a light-emitting substance, wherein the light-emitting substance is a diketopyrrolopyrrole ("DPP") represented by formula I or formula III



I

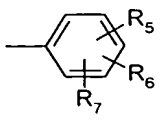
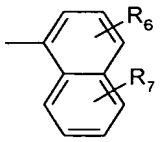
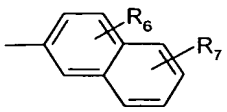
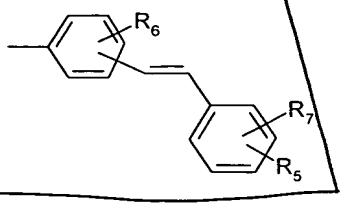


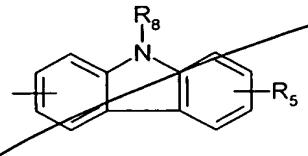
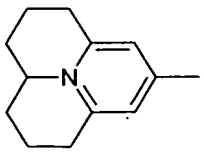
III

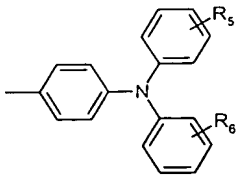
wherein R_1 and R_2, independently from each other, stand for C_1-C_{25}-alkyl, allyl which can be substituted one to three times with C_1-C_3alkyl or Ar_3, or $-CR_3R_4-(CH_2)_m-Ar_3$, wherein R_3 and R_4 independently from each other stand for hydrogen or C_1-C_4alkyl, or phenyl which can be substituted one to three times with C_1-C_3 alkyl,

Ar_3 stands for phenyl or 1- or 2-naphthyl which can be substituted one to three times with C_1-C_8alkyl, C_1-C_8alkoxy, halogen or phenyl, which can be substituted with C_1-C_8alkyl or C_1-C_8alkoxy one to three times, and m stands for 0, 1, 2, 3 or 4,

Ar_1 and Ar_2, independently from each other, stand for aryl radicals, preferably for

 or  or  or 

or  or julodidyl,  , which can be substituted one to four times with C_1-C_4alkyl, C_1-C_4alkoxy, or phenyl

or 

wherein

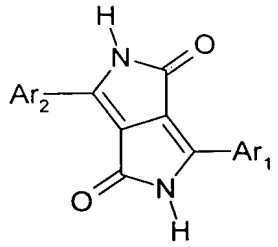
R_5, R_6 and R_7, independently from each other, stand for hydrogen, cyano, halogen, C_1-C_6alkyl, $-NR_8R_9$, $-OR_{10}$, $-S(O)_nR_8$, $-Se(O)_nR_8$, or phenyl, which can be substituted one to three times with C_1-C_8alkyl or C_1-C_8alkoxy,

wherein R_8 and R_9, independently from each other, stand for hydrogen, phenyl, C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, $-CR_3R_4-(CH_2)_m$-Ph, R_{10}, wherein R_{10} stands for C_6-C_{24}-aryl, or a saturated or unsaturated heterocyclic radical comprising five to seven ring atoms, wherein the ring consists of carbon atoms and one to three hetero atoms selected from the group consisting of nitrogen, oxygen and sulfur, wherein Ph, the aryl and heterocyclic radical can be substituted one to three times with C_1-C_8alkyl, C_1-C_8alkoxy, or halogen, or R_8 and R_9 stand for $-C(O)R_{10}$, wherein R_{11} can be C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, R_{10}, $-OR_{12}$ or $-NR_{13}R_{14}$, wherein R_{12}, R_{13}, and R_{14} stand for C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, C_6-C_{24}-aryl,

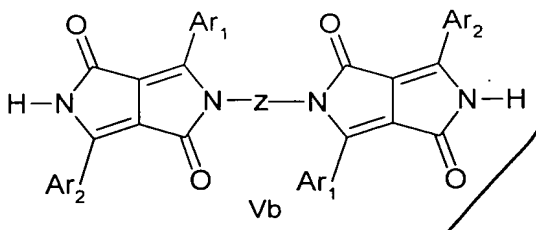
or

a saturated or unsaturated heterocyclic radical comprising five to seven ring atoms, wherein the ring consists of carbon atoms and one to three hetero atoms selected from the group consisting of nitrogen, oxygen and sulfur, wherein the aryl and heterocyclic radical can be substituted one to three times with C_1-C_8alkyl or C_1-C_8alkoxy, or $-NR_8R_9$ stands for a five- or sixmembered heterocyclic radical in which R_8 and R_9 together stand for tetramethylene, pentamethylene, $-CH_2-CH_2-O-CH_2-CH_2-$, or $-CH_2-CH_2-NR_5-CH_2-CH_2-$, preferably $-CH_2-CH_2-O-CH_2-CH_2-$, and n stands for 0, 1, 2 or 3, and wherein Z stands for a diradical selected from the group consisting of a single bond, C_2-C_6alkylene, which can be substituted one to three times with C_1-C_4alkyl, C_1-C_4alkoxy, or phenyl, phenylene or naphthylene.

2. Process for the preparation of compounds I or III according to claim 1 in treating in a first step the DPP derivative of formula Va or formula Vb



Va

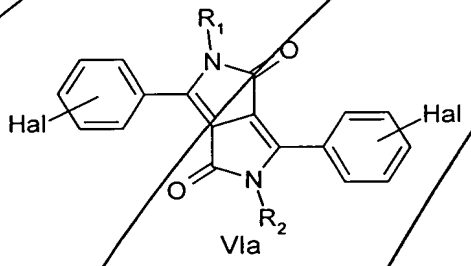


Vb

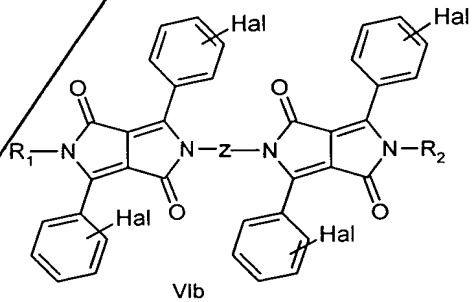
wherein Ar_1 and Ar_2 are defined as in claim 1, with a base, then, in a second step, treating the reaction mixture obtained in the first step with an usual alkylating agent, wherein in the first step the base is a hydride, an alkali metal alkoxide or a carbonate, and the alkylating agent is a sulfonate, tosylate, mesylate, carbonate, sulfate, or halogen compound of the formula $(R_1)_{1\ or\ 2}X$, wherein X stands for SO_3-, (p-Me-phenyl)SO_2-, (2,4,6-trimethyl-phenyl)-SO_2-, -CO_3-, -SO_4-, or halogen, or a mixture of $(R_1)_{1\ or\ 2}X$ and $(R_2)_{1\ or\ 2}X$.

3. Process for the preparation of compounds I or III according to claim 1

(a) in treating in a first step the DPP derivative of formula VIa or formula VIb



VIa



VIb

wherein R_1 and R_2 are defined as in claim 1, Hal stands for halogen, with a nucleophilic agent such as a secondary amine, HNR_8R_9, a thiol, HSR_8, or $HS(O)_nR_8$, an alcohol, HOR_{10}, a diselenide, $R_8(O)_nSe\text{-}Se(O)_nR_8$, preferably in a molar ratio of DPP VIa or VIb:nucleophilic agent in the range of 1.2:1 to 0.8:1, or, if R_2 has the same meaning as R_1 in the range of from 1:2.5 to 1:1, in the presence of an anhydrous dipolar aprotic solvent, and of an anhydrous base in an amount in the range of from usually 0.1 to 15 moles per mole of the nucleophilic agent, at a temperature in the range of from usually 100 to 220°C and under a pressure generally in the range of from 100 to 300 kPa, and optionally isolating the obtained compound Va, resp. Vb,

(b) then treating the obtained compound Va, resp. Vb (as defined in claim 2), with a base, thereafter in a second step, treating the reaction mixture obtained in the first step of (b) with an usual alkylating agent, wherein in the first step of (b) the base is a hydride, an alkali metal

alkoxide or a carbonate, and the alkylating agent is a sulfonate, tosylate, mesylate, carbonate, sulfate, or halogen compound of the formula $(R_1)_{1\text{ or }2}X$, wherein X stands for SO_3-, (p-Me-phenyl)-SO_2-, (2,4,6-trimethyl-phenyl)SO_2-, -CO_3-, -SO_4-, or halogen, or a mixture of $(R_1)_{1\text{ or }2}X$ and $(R_2)_{1\text{ or }2}X$.

4. Method of coloring high molecular weight organic materials by incorporating the DPP compounds I or III according to claim 1 into said materials in analogy to known methods in the art.

5. Composition comprising

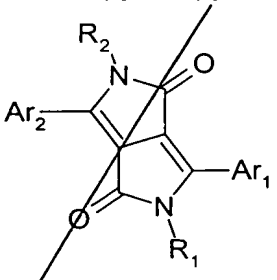
(a) 0.01 to 50% by weight, based on the total weight of the colored high molecular weight organic material, of a fluorescent DPP I or III according to claim 1, and

(b) 99.99 to 50% by weight, based on the total weight of the colored high molecular weight organic material, of a high molecular organic material, and

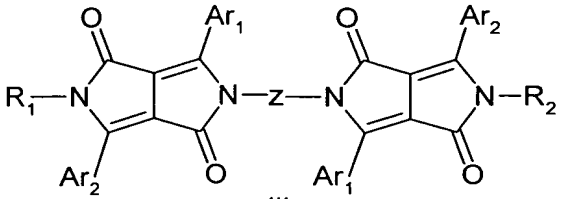
(c) if desired, customary additives in effective amounts.

6. Composition according to claim 6, wherein the high molecular weight organic material is a polyamide, a polystyrene, preferably high impact polystyrene, polymethylmethacrylate or an ABS copolymer.

7. Fluorescent diketopyrrolopyrroles represented by formula I or formula III



I

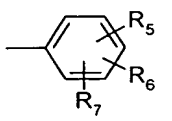


III

wherein R_1 and R_2, independently from each other, stand for C_1-C_{25}-alkyl, allyl which can be substituted one to three times with C_1-C_3alkyl or Ar_3, or -CR_3R_4-$(CH_2)_m$-Ar_3, wherein R_3 and R_4 independently from each other stand for hydrogen or C_1-C_4alkyl, or phenyl which can be substituted one to three times with C_1-C_3 alkyl,

Ar_3 stands for phenyl or 1- or 2-naphthyl which can be substituted one to three times with C_1-C_8alkyl, C_1-C_8alkoxy, halogen or phenyl, which can be substituted with C_1-C_8alkyl or C_1-C_8alkoxy one to three times, and m stands for 0, 1, 2, 3 or 4,

Ar_1 and Ar_2, independently from each other, stand for aryl radicals, preferably for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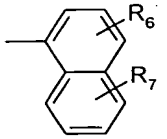
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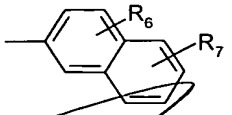
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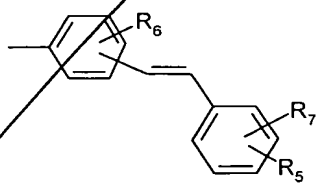

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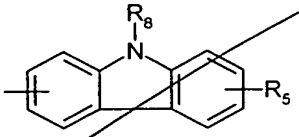
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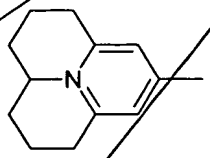
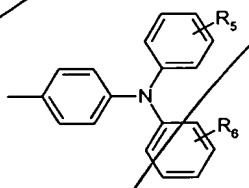

, which can be substituted one to four times with C_1-C_4alkyl, C_1-C_4alkoxy, or phenyl

or


wherein

R_5, R_6 and R_7, independently from each other, stand for hydrogen, cyano, halogen, C_1-C_6alkyl, $-NR_8R_9$, $-OR_{10}$, $-S(O)_nR_8$, $-Se(O)_nR_8$, or phenyl, which can be substituted one to three times with C_1-C_8alkyl or C_1-C_8alkoxy,

wherein R_8 and R_9, independently from each other, stand for hydrogen, phenyl, C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, $-CR_3R_4-(CH_2)_m-Ph$, R_{10}, wherein R_{10} stands for C_6-C_{24}-aryl, or a saturated or unsaturated heterocyclic radical comprising five to seven ring atoms, wherein the ring consists of carbon atoms and one to three hetero atoms selected from the group consisting of nitrogen, oxygen and sulfur, wherein Ph, the aryl and heterocyclic radical can be substituted one to three times with C_1-C_8alkyl, C_1-C_8alkoxy, or halogen, or R_8 and R_9 stand for $-C(O)R_{10}$, wherein R_{11} can be C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, R_{10}, $-OR_{12}$ or $-NR_{13}R_{14}$, wherein R_{12}, R_{13}, and R_{14} stand for C_1-C_{25}-alkyl, C_5-C_{12}-cycloalkyl, C_6-C_{24}-aryl,

or

a saturated or unsaturated heterocyclic radical comprising five to seven ring atoms, wherein the ring consists of carbon atoms and one to three hetero atoms selected from the group consisting of nitrogen, oxygen and sulfur, wherein the aryl and

heterocyclic radical can be substituted one to three times with C_1-C_8alkyl or C_1-C_8alkoxy, or $-NR_8R_9$ stands for a five- or sixmembered heterocyclic radical in which R_8 and R_9 together stand for tetramethylene, pentamethylene, $-CH_2-CH_2-O-CH_2-CH_2-$, or $-CH_2-CH_2-NR_5-CH_2-CH_2-$, preferably $-CH_2-CH_2-O-CH_2-CH_2-$, and n stands for 0, 1, 2 or 3, and wherein Z stands for a diradical selected from the group consisting of a single bond, C_2-C_6alkylene, which can be substituted one to three times with C_1-C_4alkyl, C_1-C_4alkoxy, or phenyl, phenylene or naphthylene, with the proviso that R_6 and R_7 do not stand simultaneously for hydrogen.